Learning from biological neurons to compute with noise in electronics.

Hsin Chen

Abstract :

Many implantable microsystems demand for an embedded system to recognize noisy biomedical signals reliably and power-efficiently. For example, recognizing multi-channel neural activity online is important for implantable brain-machine interfaces to avoid transmitting all data wirelessly, and to control prosthetic devices in real time, or even to deliver biofeedbacks in real time. Inspired by the interesting evidence that biological neurons are able to use "noise" to enhance computation, algorithms able to use noise for generalizing data variability have been developed.

This talk will introduce two neuro-inspired algorithms and their implementation in the Very Large Scale Integration (VLSI). By generalizing data variability with noise, the algorithms are able to cluster or classify noisy data more reliably. The VLSI implementation further demonstrates the feasibility of using noise in electronics for stochastic computation. In addition to the neuro-inspired algorithm, the natural, differential current-voltage relationship in analog circuits is exploited to simulate stochastic Hodgkin-Huxley models in biologically-realistic time. This technology will allow us to study how neurons compute with noise by forming the "hybrid neuron-silicon network".
Finally, two transistors with enhanced and adaptable noise are developed. These technologies would allow us to compute with noisy devices just like the brain computing with noisy neurons.